TAU IDENTIFICATION AT THE LHC

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An important final state in searches for the Higgs Boson in the Standard Model and super symmetric extensions is its decay into tau pairs. However, unlike other charged leptons, tau particles decay into lighter hadrons and leptons making identification of taus within particle detectors more challenging. The tau particle primarily decays into highly collimated jets of one or three charged particles consisting of lighter leptons or hadrons along with their corresponding neutrinos. In both one and three prong hadronic decays the underlying kinematics of the physics event allows for unique identification of tau jets.

Using Monte Carlo simulation techniques, the underlying properties of tau jets within the Compact Muon Solenoid (CMS) detector are analyzed. An identification algorithm similar to that used at the CDF experiment is implemented, where reconstructed tracks from the silicon detector are sorted by transverse momentum and then used to seed possible tau jet candidates. To separate tau jets from other hadronic jets a signal cone is used to define the tau jet and an isolation cone is used to separate tau events from other background events.

A full analysis of various methods for defining and parametrizing both signal and isolation cones is performed, comparing signal efficiencies with fake rates from QCD and photon $+$ jets backgrounds. It is found that for the Higgs and Z boson searches a signal cone defined in $\eta - \phi$ space parametrized with respect to jet transverse energy yields the best efficiency to fake rate ratio, while the shape and parametrization of the isolation cone is highly dependent upon the underlying physics search. A new isolation cone parametrization is proposed for lower energy physics searches dependent upon tau events.